

How to Make Extra Money **FIXING RADIOS**

NATIONAL RADIO INSTITUTE, WASHINGTON, D. C.

No. 32

**How To Service
Auto Receivers**

RADIO SERVICING METHODS



NRI TRAINING

Pays...

Dear Mr. Smith:

I am now doing radio servicing, full time. I own my shop (Radio Hospital) which is equipped with the best up-to-date instruments. Believe me, I am making more money now than I ever made before. I owe all this to NRI and I advise all young men interested in radio to take your Course.

C. S., Iowa



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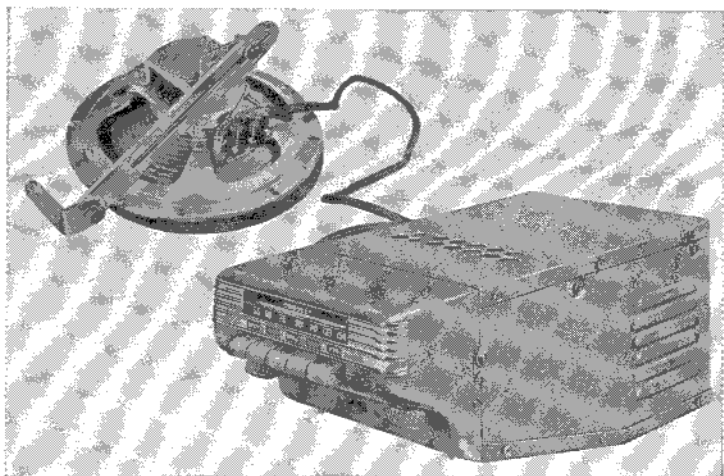
HOW TO SERVICE AUTO RECEIVERS

SERVICEMEN differ in their attitudes toward servicing auto sets. Some never handle them, others specialize in them, and still others service them occasionally. The choice is up to you. This Booklet will show you what the jobs are like, so that you can more easily make up your mind. Also, if you decide to do auto-radio servicing, then this information will be sufficient to get you started.

Although an auto receiver is basically much like a home receiver in its principles and operation, the fact that it is designed to be used in an automobile makes it subject to special difficulties that do not bother home receivers.

Most of these special difficulties come from the power supply used and from the actual installation in a car. The set must be properly placed and securely fastened, the right kind of antenna must be installed, and precautions must be taken to eliminate interference from the auto ignition. We will treat power-supply problems in this Booklet, but will not consider the problems of installing a set, as these are covered elsewhere in your Course. Here, we will concern ourselves primarily with servicing auto radios that have been properly installed and were once operating satisfactorily.

However, it is impossible to ignore the installation completely when you are servicing an auto set, for it is always possible that some of the precautions that were



Courtesy Crosley Corporation

This set, which has a separate speaker, is representative of one of the two main types of auto radios. Its speaker is usually mounted behind a grille in the dash, and the set itself is mounted under the dash. In the other type, the speaker is a part of the set; the whole unit is mounted in or under the dash.

taken to eliminate interference have failed of their purpose. One of the first steps, therefore, in servicing an auto set is to make sure that it is the set and not the installation that is to blame.

If the set itself is defective, you will find that most complaints are caused by the same defects that produce similar complaints in home receivers. However, the electrical and mechanical differences between auto and home sets do create some defects in the former that are not found in the latter. Let's see just what these differences are.

Electrical Differences. The chief electrical difference, of course, between an auto radio and a home set is in their power supplies. The auto set must get its operating voltages from a 6-volt battery rather than from a power line. To get the high voltage step-up needed, an auto set usually contains a vibrator that interrupts the flow of d.c. current into the set many times a second, thereby producing sharp voltage pulses. The a.c. components of these pulses can be stepped up by a transformer. Police cars and other special installations sometimes use small motor-generator sets instead, but

these are rarely found in private cars. The earliest auto radios used bulky and expensive B batteries as power sources, but no modern set does so.

A second important difference is the fact that an auto set must have extremely high sensitivity because the antenna used with it will be, at best, only a short one. For this reason, auto sets have high-Q circuits throughout their r.f.-i.f. sections. In addition, some sets have a tuned r.f. amplifier ahead of the oscillator-mixer stage, and others deliberately include a certain amount of regeneration. These features, which, as we will see, can complicate your servicing problems, are sometimes found in home receivers, but not nearly as often as in auto sets.

There are two other ways in which auto and home receivers differ electrically. An auto radio must have a fast-acting a.v.c. system to counteract variations in signal strength as the car is driven from place to place. And, since the set normally works in an intense interference field, special shielding and filtering are required.

Apart from these four factors, an auto set does not differ electrically from a home receiver. Notice how closely the circuit diagram of a typical auto set in Fig. 1 resembles the diagrams with which you are now familiar.

Mechanical Differences. Since an auto set must usually be mounted in a rather small space under the dash of a car, it is far more compactly constructed than most home receivers. It is frequently equipped with mechanical remote controls worked through a flexible shaft. Further, it is always ruggedly built to withstand shock and vibration.

The extreme compactness of the set often makes it quite a problem to replace a part. Also, it is frequently necessary to use exact duplicate parts; it may be impossible to use universal replacement parts because of the space limitation and the need for particularly strong construction.

► Now that we have established the major differences between home and auto receivers, let's see what you need in the way of special equipment for servicing the latter.

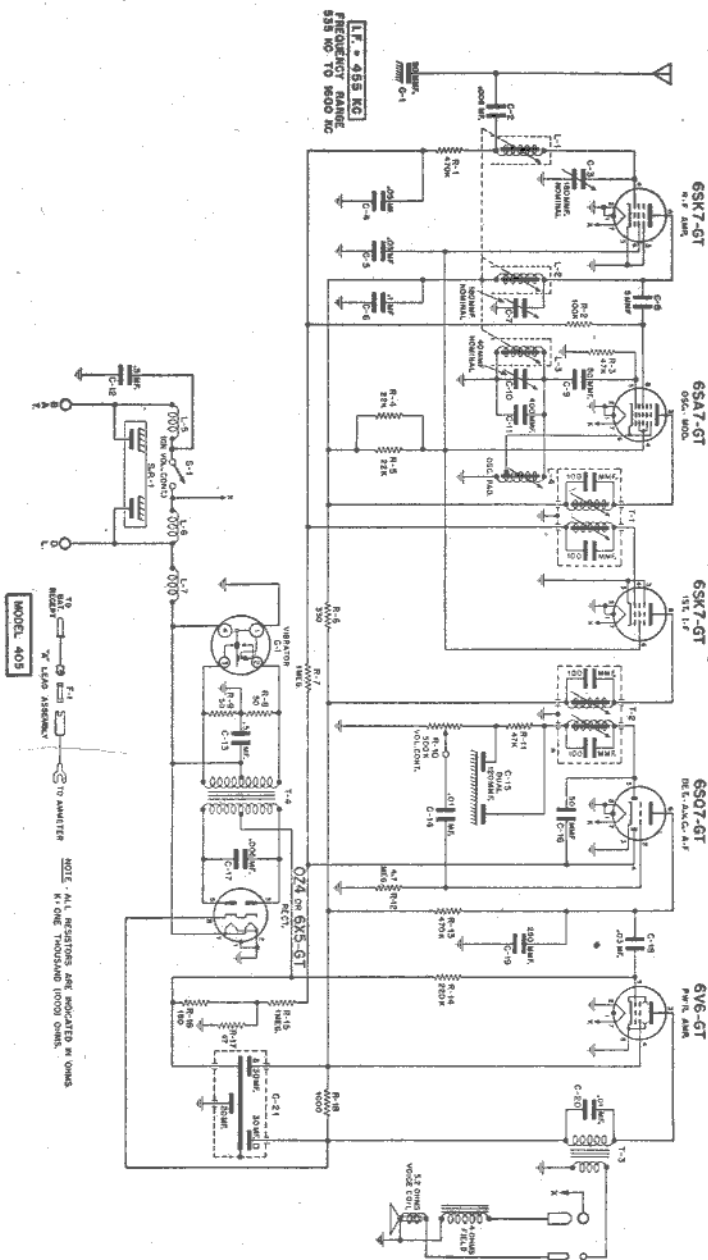


FIG. 1. This is the manufacturer's circuit diagram of a typical small auto radio, the Motorola 405. Notice that it uses permeability tuning in the r.f.-i.f. section.

EQUIPMENT NEEDED FOR AUTO SET SERVICING

The first requirement for servicing auto sets is a place in which to work. You should never try to work on a radio in a car that is parked on the street; it may be dangerous to do so, and it is almost always inconvenient. The best arrangement is to have your customer drive his car right inside your shop, if you have a location that will permit this, or at least into a private driveway or parking area beside the shop. This will let you work in safety, with your tools near at hand. If you are doing work for a car dealer, work in his garage.

Next, you will need a 6-volt power source. You can use a storage battery, or a power pack—sometimes called an A battery eliminator—that will furnish 6 volts d.c. from 115-volt a.c. power lines. Several firms make these power packs especially for auto radio servicing. If you get a storage battery, you should also get a trickle charger so that you can keep the battery in good condition.

For convenience, you should mount your storage battery or power pack behind or underneath your bench and bring a cable up to the bench from it. This cable should be No. 10 wire and should be as short as possible—remember, a battery is a low-voltage source, so even a relatively small voltage drop in your leads may prove troublesome. If you use a battery and trickle charger, use the circuit shown in Fig. 2 to connect them. This arrangement will keep the battery fully charged at all times.

You will need a certain amount of other special equipment also. For one thing, you will need a pair of thin, strong, adjustable end wrenches for removing the receiver from the car. (A set of box or end wrenches can be used instead.) You will also need a supply of tinned copper braid to be used either to shield wires or to bond parts of the car together, some lock washers of various sizes, some type 3AG auto fuses with different ratings (between 5 and 20 amperes), and a few universal vibrators. These, of course, are in addition to the usual supply of radio parts, tools, and equipment. Your regu-

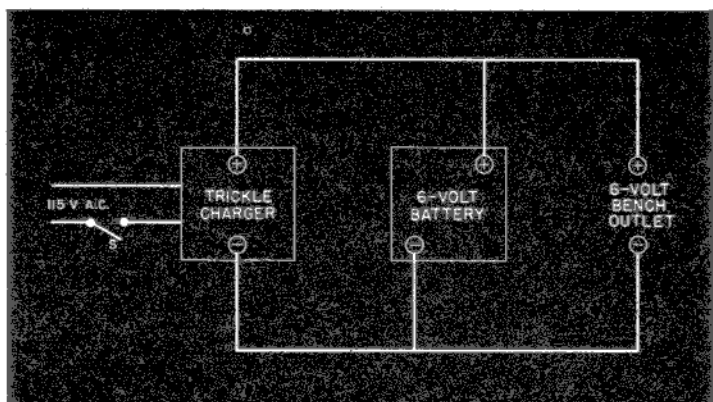


FIG. 2. To prevent excessive voltage drops in the wiring, be sure to use No. 10 wire for all low-voltage connections in this power supply. Leave it connected to the power line, with the power switch on, except when the battery is fully charged.

lar servicing instruments—multimeter, tube tester, and signal generator—will be sufficient to locate defects.

Localizing the Trouble. As we said earlier, an auto set that is not operating properly may not itself be defective; the installation in the car may instead be to blame. Therefore, the first step in servicing an auto set is to find out whether the installation or the set is at fault. The tests you make to determine this depend on what the complaint is. Let's take up the most common complaints in order, showing you in each case how to tell whether the installation or the set is to blame.

NOISY RECEPTION

Noise is one of the most common complaints in auto sets. It is more apt to be caused by the installation than by the set, so you should check very carefully before assuming that the set is to blame.

The receiver itself may have any of the defects that produce noise in home receivers—broken wires, corroded shielding, bad tubes, defective resistors, bad condensers, and loose connections. In addition, the vibrator power supply of the auto set can cause a "hash" when the vibrator is defective or the filtering system used with it breaks down.

► Noise resulting from installation may be caused by

a car's ignition system, by static interference produced when the car is running, or by poor bonding. (Bonding is the process of making good electrical connections between the various metal parts of the car with strips of flexible braid. For example, the hood of the car is usually bonded to the body, and the body to the frame; when this is done properly, the receiver is effectively shielded from the ignition system of the car.)

Ignition noise, or interference, is produced by the ignition system of the car. It may originate in the generator or in the regulating relays in the low-voltage section of the car's electrical system, or it may be caused by the distributor or spark plugs in the high-voltage section. When the engine is running, small electric arcs produce pulses of energy at each of these locations and set up r.f. noise signals on the associated cables. If the ignition system is not properly shielded, the radiation from these points may produce noise in the set. Of course, this noise cannot occur when the car engine is not running.

Static discharges, on the other hand, are not dependent upon the electrical system of the car. They result from friction between moving and stationary parts. For example, static charges are built up on the tires as the car rolls over the road; these static charges may discharge suddenly when they have built up far enough, thus producing a miniature lightning flash that may create a burst of noise in the set. The car must be moving to produce static interference of this sort, but the engine does not have to be running.

Another possible source of noise in the installation is the connection between the antenna and the receiver. The vibration of the car as it moves may create a loose connection between the lead-in and the antenna or between the lead-in and the set. Either of these conditions can cause noise.

Localizing Noise. A few simple tests will show whether or not the set or the installation is to blame for the noise. First, turn on the radio with the *antenna disconnected*, the car engine *not running*, and the car *stationary*. If you hear noise under these conditions, you can be sure that the set itself is causing the noise, since

all other possible sources of noise have been eliminated.

Reconnect the antenna, and wiggle the antenna lead-in. (The motor should not yet be running.) If this causes noise, install a new lead and see if the noise disappears. Don't attempt to fix the old one, since it probably can't be done.

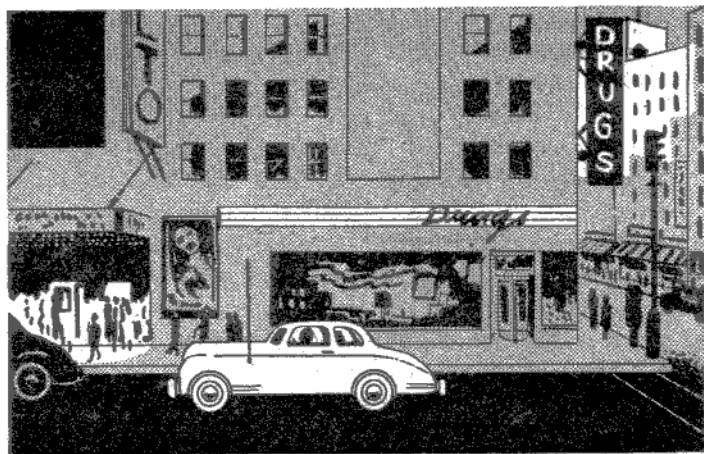
If you hear no noise, start the engine and allow it to idle. If you hear noise now, it is caused by the car ignition system, and the set can be considered to be all right. If you do not hear noise, speed the engine up somewhat; some ignition difficulties do not occur until the engine is moving at fairly high speed.

If the noise has not yet appeared, give the car a road test. Coast down a hill with the engine turned off. Noise under these conditions probably means that there are static discharges.

► This series of tests should tell you whether or not the set is to blame. There is a slight possibility of making a mistake: it may be that there is a loose connection within the set that will produce noise when the car engine is running, because of the vibration produced. In this case, you may think that the noise is caused by the installation rather than by the set, since there will be no noise when the car is stationary, and the engine is not running. In some sets, you can check for loose connections by slapping the side of the set—have the engine turned off and the car standing still. If doing so produces noise, you can be sure that there is some loose connection within the set.

WEAK RECEPTION

Weak reception may be caused by receiver defects, by defects in the installation, or by natural conditions over which you have no control. Before making any localizing attempts, you should question the owner carefully to find out if the set is weak all the time, or only in certain locations, or only at specific times. This will often show you whether or not natural effects are the real cause of the complaint. For example, it is normal for the signal of a distant station to be weak in a city because of the shielding effects of steel-framed buildings. Also, a certain amount of weak reception is to be expected in



Steel-framed structures, such as buildings or bridges, act as shields for radio waves. Reception on a car radio is naturally poor when the car is in the vicinity of such structures. If the car passes through a shielded area in a short time, the signal will appear to fade; if it stays in the area for some time, the set will seem to be weak.

country driving because of the erratic way in which radio waves vary in strength in certain locations (in mountainous or valley regions, for instance). However, if the set is weak on local stations that other auto receivers in the same location bring in strongly, it is reasonable to suppose that it is defective.

Before blaming the set, however, make sure that the auto battery is in good condition. Auto receivers draw a rather high current—as much as 10 amperes—so a battery that is running low may be unable to supply enough power to keep the set working well. If the set is weak when the engine is idling but improves when the engine speed is increased, check the storage battery with a hydrometer to make sure it is reasonably near full charge. If it is not, the charging rate of the generator may need adjustment. It is always worth while to check the battery when the complaint is weak reception, especially in the winter time, when the combination of cold weather and increased power-demand may run down a car battery rather quickly.

A poor antenna installation can often be the cause of weak reception. Check for leakage from the antenna to

the car chassis with a high-range ohmmeter. Also, be on the lookout for poor connections between the antenna and the set.

FADING

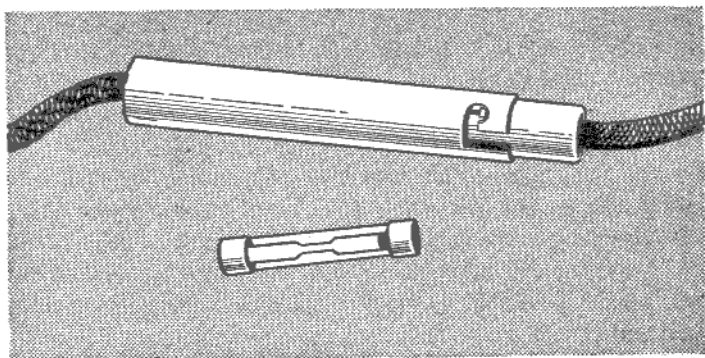
As we have already said, the antenna of a car set is so short that very little signal is supplied to the input of the receiver. When this small signal is further reduced because the car comes near some natural shield, such as a steel bridge, it is only normal that the volume of the receiver should decrease. Car radios are equipped with fast-acting a.v.c. systems to compensate for some of the natural fading caused when the car moves from a region of high signal level to an area where the signal level is low, but the compensation that the a.v.c. system can introduce is limited. You can expect the signal to fade considerably, or even vanish completely, when the car comes close to any large steel framework.

However, the signal should not fade appreciably when the car is standing still and the set is tuned to a local station. If it does do so, you can be sure that something is the matter with the set. A further check of this is to try a portable radio in the same location. If it shows no sign of fading, but the car radio you are testing does, you can be sure that the car radio needs repairs.

DEAD SET

When a car set is dead, the very first thing you should do is check the fuse in the power lead of the set. This lead, called the hot "A" lead, is usually connected to the electrical system of the car at or near the car ammeter. (Only one lead is used to supply power to the set in all modern cars; one terminal of the car battery is grounded to the car body, and the return lead from the set to the battery is made by grounding the set to the body also.) There is always a fuse in this power supply lead; it may be inside the set, or, more commonly, in a fuse holder that forms part of the lead. If this fuse is blown, insert another fuse of the same rating in the fuse holder, and try the set. If this fuse blows, you can be sure that something is wrong with the set.

Other tests you should make include a visual check



A typical fuse and fuse retainer, shown approximately full size, of the sort used in the hot A lead of many car radios. In use, the fuse is inside the retainer. When an auto set is dead, find this retainer, open it, and examine the fuse, before making any other tests; a blown fuse is one of the most common causes of a dead set.

to be sure there is a good connection between the hot "A" lead and the car's electrical system. Make sure the car battery is fully charged, also. A low battery will usually cause a weak rather than a dead set, but it is worth making the check anyway.

► The vibrator of a car radio makes a distinctive humming sound that you will quickly learn to recognize. If you hear no hum from the vibrator when you turn the set on, almost certainly there is something the matter with the power supply to the set. If you hear the vibrator hum when the set is turned on, yet the set does not play, check the antenna lead to make sure it is not broken and that it makes a good connection to the set. If you are not sure about the antenna lead, disconnect it from the set completely, and connect a 10-foot length of insulated copper wire to the set as an antenna. If the set now plays, there is something the matter with the antenna connection; if it does not play, the defect is in the set (assuming that you have already made the tests described in the preceding paragraphs).

SERVICING THE SET

From what we have said, you can see that you should make very careful tests before you pull the set out of the car to check it. One good reason for doing so is that it is

often rather difficult to take an auto set out. For this reason, practically all auto sets are made so that you can remove the top or side and pull out the tubes without having to take the set out of the car. *You should always check all tubes in a tube tester before removing the set, no matter what the complaint.* Also make sure that all tubes are seated properly in their sockets; the vibration of the car may sometimes work a tube loose.

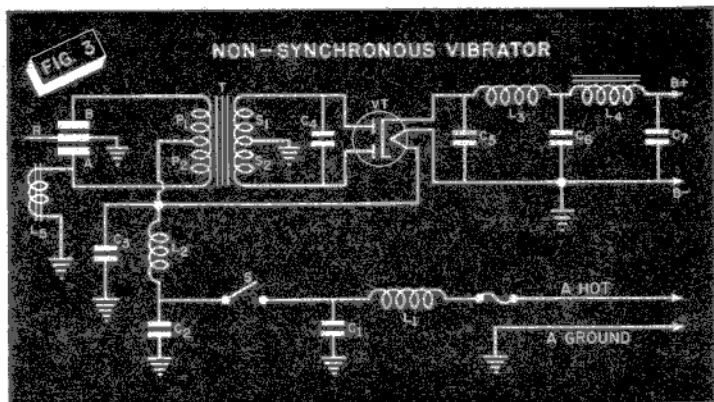
If testing the tubes does not point out the cause of the complaint, you will be forced to remove the set from the car and take it to your bench for testing. It may be difficult for you to remove the set alone—you may need a helper to hold the set while you loosen the holding bolts. (Some sets are hung on simple hangers and can be lifted out easily.) If manufacturer's instructions are available, by all means read them carefully for hints on installation and removal. Be sure to notice exactly how the remote-control cables are fastened to the set, if they are used, and to tag them so that you will know which goes where when you put the receiver back in.

Once you have the set on your bench, the tests you will make will be much the same as those you would use if you were servicing a home receiver with the same complaint, except that the vibrator power supply used in an auto set will require special treatment. To refresh your memory on the subject of vibrator supplies, let's review the operation of the two common types before we learn how to service the sets that use them.

HOW VIBRATORS WORK

There are two main kinds of vibrators, known as the "synchronous" and the "non-synchronous" types. Figs. 3 and 4 show diagrams of typical power supplies using each type.

Essentially, the chief working part of a vibrator is a flexible reed that is moved by an electromagnet. This reed vibrates in a gap between sets of contact points. As it moves, it alternately makes and breaks contact with these points. This intermittent switching action does two things: 1, it keeps the vibrating reed going, because the circuit is so arranged that the switching alternately energizes and de-energizes the electromag-



net; and 2, it produces sharp changes in current flow, chopping up the d.c. current from the battery into pulses, so that the a.c. components can be fed through a transformer.

The non-synchronous vibrator shown in Fig. 3 has only one pair of fixed contacts. If you trace the circuit from the battery you will see that when switch S is closed, current flows through L_1 , L_2 , P_2 , and L_5 (the coil of the electromagnet) to ground. The coil then attracts the vibrating reed R , pulling it down until it hits contact A. This permits full current to flow through P_2 and also shorts L_5 , causing it to release the reed. The reed then flies back, striking contact B, and completing a circuit through P_1 . Then coil L_5 again attracts the reed, repeating the cycle.

The pulsing current flow first through P_2 and then through P_1 induces an a.c. voltage in the secondary of transformer T . This voltage is then rectified by tube VT and passed on to the filters. Since the voltage produced across the secondary by this system has very high, sharp peaks, the buffer condenser C_4 is connected across the secondary. This condenser tends to smooth out the peaks to some extent. Even so, the rectified output contains considerable "hash" (that is, it has an irregular wave shape caused by the presence of many high harmonics). That is why the elaborate (high- and low-frequency) filter system C_5 - L_3 - C_6 - L_4 - C_7 is used in the power supply.

► The synchronous vibrator power supply, shown in

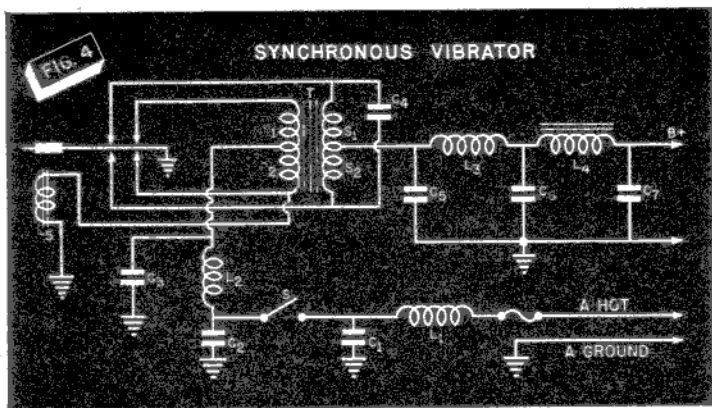


Fig. 4, uses a mechanical system to rectify the secondary voltage of the transformer, thereby making it unnecessary to have a rectifier tube in the set. It is not as popular as the non-synchronous vibrator already described, chiefly because it is more complex, and therefore more prone to failure.

As you can see from the circuit diagram, the synchronous vibrator is similar to the non-synchronous in the method used to connect its operating electromagnet to the car battery. Notice, however, that two sets of contacts are used in the synchronous vibrator, one connected to the primary of the transformer, the other to the secondary.

The contacts connected to the secondary of the transformer provide mechanical rectification of the secondary output. As you can see from Fig. 4, the B— terminal of the vibrator output is grounded, as is also the vibrating reed. Therefore, the two ends of the secondary of the transformer are alternately connected to the B— terminal through ground as the reed touches the secondary contacts. If the proper connections are made between these contacts and the secondary of the transformer, each end of the secondary will be connected to B— during the half-cycle that it is negative with respect to the other end of the secondary. This will produce rectification, for the vibrator output will then always be negative at the terminal marked B— and positive at the terminal marked B+.

However, reversing the connections to the battery

will reverse the polarity at the B+ and B— terminals of the vibrator output. If this were to happen, the electrolytic filter condenser C_6 across the vibrator output would be quickly ruined. Therefore, it is important to make sure that a synchronous vibrator is connected to the car battery with the proper polarity. As we shall show in a moment, this means you must be more careful when you are making bench tests on a set that uses a synchronous vibrator.

► Vibrators, like tubes, wear out and must be replaced. After a while the vibrating reed loses its springiness, and the contacts become pitted and worn. This will happen even if no defect exists in the receiver. In addition, if there is leakage or shorts in the B supply circuits of the receiver, more than the normal current will flow through the vibrator contacts, and their useful lives will be further shortened.

The easiest way to test a vibrator is to insert one that you know is good in its place. Most modern vibrators are equipped with a plug-in base that fits a socket resembling a tube socket; such vibrators can be removed as easily as a tube for testing. In some of the older sets, however, it is necessary to unsolder connections to the vibrator to make tests.

If you do a great deal of auto receiver servicing, you will find it worth while to get a vibrator tester. This is an instrument that resembles a tube tester in its operation. The vibrator is plugged into the proper socket, and measurements are made of the voltage output and the current drain while the vibrator is furnishing power to a load. The vibrator is satisfactory if it delivers a rated voltage with a minimum current drain.

Whenever you must replace a vibrator, you should always check the buffer condenser (C_4 in both Fig. 3 and Fig. 4). These condensers have high voltage ratings—1200 to 2000 volts—but they frequently break down as a result of continued high-voltage surges. If you must replace a buffer condenser, remember that its capacity and voltage rating were originally selected by the manufacturer to match the vibrator and the transformer with which it is used. Therefore, a replacement buffer condenser should have exactly the same capacity as that

of the original, and a voltage rating at least as high. ► You should always suspect a power supply defect if an auto set draws excessive current or if the vibrator rate of operation seems to vary. Excessive current does not always mean that the vibrator itself is defective, for there may be some defect in the set that is causing the abnormal current drain; however, all the current drawn by the set must pass through the vibrator, and, if too much current flows, the vibrator will usually be damaged. Therefore, although the vibrator may not be the original cause of the excessive drain, it may very well become defective after the drain has continued for a while. At the very least, its future useful life will be shortened.

► Now that we have reviewed the subject of vibrator power supplies, let's see how to go about testing an auto set after removing it from the car. Remember, we know that the set itself is defective, because we have already checked the installation.

PREPARING THE SET FOR TEST

You will need a short antenna to test an auto set at your bench. Use an auto antenna or four or five feet of wire. Don't make the mistake of using a long antenna; the set will be overloaded and may even oscillate.

When you connect the set to your battery, connect one battery terminal to the "hot" lead, and the other to the receiver chassis (or the enclosing case). We pointed out earlier that it is important to connect a battery to the set with the proper polarity if the set has a synchronous vibrator. This is not necessary if the set has a non-synchronous vibrator, for the latter type uses a rectifier tube that maintains the proper polarity on the output of the power pack. However, if you don't know whether the set uses a rectifier tube, play safe and connect the set to your battery or bench power supply with connections of the same polarity as those used in the car. You can then be sure that the output of the power supply will have the correct polarity whether or not a synchronous vibrator is used in it.

► If you have a set with a synchronous vibrator, and you are not sure how the battery was connected to the

set in the car, check the polarity of the vibrator power supply output by connecting the set to your test battery, then pulling out the output tube and connecting your d.c. voltmeter between the output tube plate terminal socket and the receiver chassis (positive lead of your voltmeter to the plate terminal). Turn on the set. If the meter reads upscale, connections have been made to the set with the proper polarity. If it reads downscale, disconnect the set at once from the battery and reverse the connections. If you get no reading at all on the voltmeter, the set power supply is defective.

► When you use an ohmmeter to check the B supply circuit of a set that uses a synchronous vibrator, be sure to disconnect or remove the vibrator before making continuity measurements. The vibrating reed may rest against one set of contacts when the receiver is not operating; this will ground one end of the secondary of the transformer and give incorrect measurements. It is unnecessary to do this in a set that uses a non-synchronous vibrator, for the power-supply output of such a set is isolated from the vibrating reed, and your ohmmeter measurements will not be affected whether or not the reed touches a contact.

LOOKING FOR SURFACE DEFECTS

You should always look for surface defects in an auto set, just as you do when you service any other type of set. Make an even more thorough examination than usual on an auto set, however, for the vibration to which the set is subjected when it is in a car makes it much more probable that the set will have some mechanical defect.

For example, make sure that all tubes fit tightly in their sockets. (Many auto sets use loctal tubes that are supposed to fit tightly at all times; however, even with these types, it is always possible that something has gone wrong with the locking arrangement on a tube or that someone has inserted a tube in its socket incorrectly.) You should make this test while the set is in the car whenever possible, but it is wise to check it again when the set is on your workbench.

Look carefully, too, for bolts, nuts, and lock washers

that have been worked loose by the vibration and have become lodged underneath terminal strips, resistors, or condensers. Loose hardware of this sort can cause shorts. Make sure, also, that all wire connections, tube top cap connections, and shield cans are tight. •

The general servicing procedures for an auto set, once you have it on your workbench, are the same as those you would use for a home receiver. In the following sections on specific receiver complaints, we will not go into the tests with which you are already familiar, but will instead describe tests that apply specifically to an auto set.

SERVICING A DEAD SET

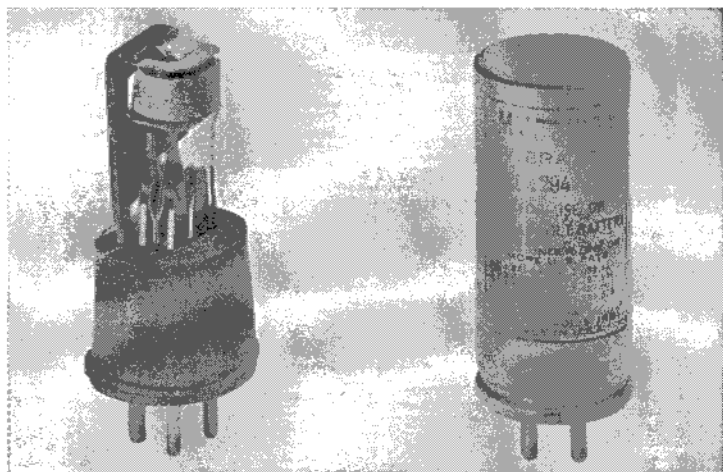
If the set is dead, listen for the vibrator hum. If no sounds at all come from the speaker, and you cannot hear any sound directly from the vibrator, the vibrator is defective or is not getting power. (Look for a blown fuse, or a break in the A lead.) On the other hand, if the vibrator buzzes, but no sound comes from the speaker, the defect is in the rectifier-filter section of the power supply, or is caused by a short circuit across the B+ and B— terminals. (Remember, if the vibrator is of the synchronous type, to remove it before making ohmmeter tests in the power supply.) If the sound the vibrator makes is unsteady, check the vibrator itself and the buffer condenser.

If the vibrator buzzes, and you hear a slight hum from the speaker, proceed to locate the defective section and stage as you would in any set.

SERVICING A SET THAT HUMS

Because it uses a vibrator, an auto set is an a.c.-operated device (even though its original power comes from a battery) and is therefore subject to hum. Vibrators usually operate at a frequency around 115 cycles (some go as low as 85 cycles, some as high as 165 cycles, but most are at or near 115 cycles) so the basic hum frequencies for an auto set will be either 115 or 230 cycles, rather than the 60 or 120 cycles that you find in sets operating on power lines.

Cathode-to-heater leakage cannot normally cause



Courtesy P. R. Mallory and Co., Inc.

Internal and external views of one popular kind of non-synchronous vibrator. Notice that four sets of contacts are used, instead of the two indicated for the non-synchronous vibrator in Fig. 3. Electrically, however, this vibrator and that shown in Fig. 3 are identical, for the pairs of contacts on each side of the vibrating reed are connected in parallel. This arrangement permits the contacts to carry fairly heavy currents without burning or pitting.

hum in an auto set, because the filament supply is d.c. This leakage is more likely to upset the bias and cause distortion, or to permit the vibrator hash (noise) to be increased.

Remember that the vibrator may be fairly noisy in its operation. Do not mistake the normal buzz of the vibrator for hum in the set. (Of course, if the vibrator is excessively noisy, it may be well to replace it even though it operates satisfactorily.) Also, remember that the vibrator noise and hum may be rather noticeable on your bench in your quiet shop, but may be masked entirely when the set is in a car.

SERVICING A NOISY SET

An auto set can be noisy for any of the reasons that a home receiver is. In particular, it is subject to noise caused by loose connections because of the mechanical strain to which it is subjected in a running auto. You can be rough with the set when noise is the complaint.

Don't be afraid to drop it an inch or so onto your bench to see if you can cause the noise to appear. An auto set should be strong enough to withstand much greater shocks than this, and it may be necessary to vibrate it rather strongly before you can make a noise appear with the set out of the car.

► There are two possible sources of noise in an auto set that you will not find in home receivers. One is the cold-cathode rectifier tube used in some sets. Such a tube is subject to gas oscillation, which will cause noise. The easiest way to check this tube is to substitute a good one in its place. If you find this stops the noise, you can, if you wish, leave the good tube in. However, since this tube may also become noisy later on, many servicemen make a practice of substituting a heater-type rectifier with a similar rating (if the car battery does not have too many gadgets to power). Usually the only change you have to make to use a heater-type tube is to wire in the filament circuit; in some sets, you will find this has already been done by the manufacturer.

► Another source of noise in auto sets is vibrator hash. The buffer condenser is designed to reduce the high surge peaks, and to reduce the sparking at the vibrator contacts, that cause this noise. However, if the buffer condenser becomes defective, the wave form of the vibrator output will change, and the filters may not be able to remove the a.c. components of the altered wave. This will usually cause a rasping noise from the speaker. Remember that the capacity of a replacement buffer condenser should be very close to that of the original. Watch the voltage rating too—values of 1200 to 2000 volts are used for the buffer.

Vibrator hash may also be caused by defects other than a defective buffer condenser. Worn vibrator contacts may be at fault, or the power supply shielding may have loosened. Watch for corrosion around the screws holding the shielding in place.

SERVICING A SET THAT OSCILLATES

An auto set is more prone to oscillation than is a home receiver, because it is far more sensitive. Some very slight defects may cause trouble. Look for loose shield-

ing, and for corroded shield mountings. You may have to be very careful about how the leads are positioned. The alignment will have to be checked carefully. Look for poor connections, too.

Some sets use regeneration to increase their sensitivity. In such a set a change in the characteristics of a tube can cause excessive regeneration and, therefore, oscillation. You may be able to cure this with another tube, or you may have to adjust the position of the feedback coil if such an adjustment is possible.

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